

CLAIMS

What is claimed is:

- [c1] An electromagnetic link system comprising:
- a first electromagnetic transducer sealingly disposed in an outer wall of a tool mandrel, the mandrel adapted to be positioned in a drill collar;
 - a second electromagnetic transducer sealingly disposed in an interior of a port in the drill collar, the second transducer disposed proximate the first transducer when the mandrel is positioned in the drill collar;
 - a third electromagnetic transducer sealingly disposed in an exterior of the port in the collar, the second and third transducers defining a sealed chamber in the port, the second and third transducers electrically coupled to power conditioning and signal processing circuits disposed in the chamber; and
 - a fourth electromagnetic transducer positioned proximate the third transducer, the fourth transducer electrically coupled to at least one of a sensor, an external communication line and an external power line.
- [c2] The system as defined in claim 1 wherein each of the transducers comprises a winding formed on a bobbin, each bobbin adapted to sealingly enclose a corresponding one of the windings, each winding having a principal magnetic moment substantially perpendicular to a wall of the mandrel and the drill collar.
- [c3] The system as defined in claim 2 wherein each bobbin is formed from a material having a lower magnetic permeability than the drill collar and the mandrel.
- [c4] The system as defined in claim 1 wherein the at least one circuit in the mandrel comprises a controller adapted to receive instructions from a recording and signal processing unit, and wherein the fourth transducer is disposed in a device adapted

to be affixed to the exterior of the collar, the fourth transducer electrically coupled to the recording and signal processing unit.

- [c5] The system as defined in claim 1 further comprising at least one sensor disposed in the wall of the drill collar, the at least one sensor operatively coupled to the signal processing and power conditioning circuits disposed in the chamber.
- [c6] The system as defined in claim 5 wherein the at least one circuit in the mandrel is adapted to receive calibration data from a recording and signal processing unit and wherein the fourth transducer is disposed in a device adapted to be affixed to the exterior of the collar, the fourth transducer electrically coupled to the recording and signal processing unit.
- [c7] The system as defined in claim 5 wherein the signal processing and power conditioning circuit in the collar is adapted to receive calibration data from a recording and signal processing unit and wherein the fourth transducer is disposed in a device adapted to be affixed to the exterior of the collar, the fourth transducer electrically coupled to the recording and signal processing unit.
- [c8] A method for interrogating a data storage device disposed in a mandrel, the mandrel disposed in a drill collar, comprising:
sending an interrogation command signal through an external device clamped onto
an exterior wall of the drill collar;
electromagnetically transferring the signal between the external clamp-on device
and an exterior wall of the drill collar;
electromagnetically transferring the signal between an interior wall of the drill
collar and an exterior wall of the mandrel;
coupling the signal to a processor in the mandrel to cause the processor to export
data in the storage device;

electromagnetically transferring the data between the exterior wall of the mandrel and the interior wall of the collar; and
electromagnetically transferring the data between the exterior wall of the collar and the external clamp-on device.

[c9] The method as defined in claim 8 further comprising reprogramming a controller disposed in the mandrel by sending a reprogramming signal to the external device.

[c10] The method as defined in claim 8 further comprising prior to the interrogating:
operating a sensor disposed in the collar to generate a sensor signal;
electromagnetically transferring the sensor signal between the interior wall of the collar and the exterior wall of the mandrel; and
conducting the sensor signal to the storage device.

[c11] A method for operating a sensor, comprising:
electromagnetically transferring electrical power from circuits in a mandrel disposed inside a drill collar between an exterior wall of the mandrel and an interior wall of the collar;
conducting the electrical power to the sensor to operate the sensor;
conducting signals generated by the sensor to a location proximate the interior wall of the collar;
electromagnetically transferring the sensor signals between the interior wall of the collar and the exterior wall of the mandrel; and
conducting the sensor signals to the circuits in the mandrel.

[c12] The method as defined in claim 11 wherein the conducting the electrical power and the sensor signals between the collar and the sensor is performed electromagnetically.

[c13] The method as defined in claim 11 further comprising:

storing the sensor signals in a storage device in the mandrel;
sending an interrogation command signal through an external device clamped onto
an exterior wall of the drill collar;
electromagnetically transferring the command signal between the external clamp-
on device and an exterior wall of the drill collar;
electromagnetically transferring the command signal between an interior wall of
the drill collar and an exterior wall of the mandrel;
coupling the signal to the circuits in the mandrel to cause the circuits to export
data in the storage device;
electromagnetically transferring the data between the exterior wall of the mandrel
and the interior wall of the collar; and
electromagnetically transferring the data between the exterior wall of the collar
and the external clamp-on device.

- [c14] The method as defined in claim 13 further comprising reprogramming a controller disposed in the mandrel by sending a reprogramming signal to the external device.
- [c15] The method as defined in claim 11 further comprising digitizing the sensor signals in a signal processing unit disposed in the drill collar prior to electromagnetically transferring the signals to the circuits in the mandrel.
- [c16] The method as defined in claim 15 further comprising electromagnetically transferring a gain value and an offset value for at least one of the sensor signals to the circuits in the mandrel.
- [c17] The method as defined in claim 16 further comprising:
attaching a device having an electromagnetic transducer element therein to an exterior wall of the drill collar, the device coupled to a system adapted to generate calibration instructions;

electromagnetically transferring the calibration instructions to the signal processing unit in the drill collar;
operating the sensor so as to determine at least one gain and offset value for at least one of the sensors; and
storing the at least one gain and offset value in the signal processing circuit.

[c18] The method as defined in claim 17 further comprising electromagnetically transferring the at least one gain and offset value to the circuits in the mandrel.

[c19] A sensor system, comprising:

at least one sensor disposed in a wall of a drill collar;
a signal processing and power conditioning circuit disposed in the wall of the drill collar and operatively coupled to the at least one sensor, the signal processing and power conditioning circuit adapted to provide operating power extracted from an electromagnetic link, the signal processing and power conditioning circuit adapted to digitize, locally store and transmit signals generated by the at least one sensor; and
a first electromagnetic transducer disposed in the drill collar and adapted to transfer power and signals to a second electromagnetic transducer disposed in a mandrel when the mandrel is disposed at a selected position inside the drill collar, the second transducer operatively coupled to signal processing circuits in the mandrel.

[c20] The sensor system as defined in claim 19 further comprising a third electromagnetic transducer disposed the drill collar and adapted to electromagnetically coupled to a fourth electromagnetic transducer adapted to be affixed to the exterior wall of the drill collar, the fourth electromagnetic transducer adapted to be coupled to a device adapted to provide calibration instructions to the signal processing and power conditioning circuit, and wherein the signal

processing and power conditioning circuit is adapted to execute the calibration instructions and receive electrical power from the device adapted to provide calibration instructions by electromagnetic transfer between the third and fourth transducers.

- [c21] The sensor system as defined in claim 19 wherein the signal processing and power conditioning circuit is adapted to transmit calibration data to the signal processing circuits in the mandrel, and the signal processing circuits in the mandrel are adapted to generate calibrated sensor signals for at least one of recording therein and transmission of the calibrated sensor signals through a mud flow modulation telemetry device.